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AUTHOR Anastasio, Ernest J.; Alderman, Donald L.
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INSTITUTION Educational Testing Service, Princeton, N.J.
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ABSTRACT

This evaluation of the Programmed Logic For Automatic Teaching Operations (PLATO) and Time-Shared Interactive Computer-Controlled Information Television (System) (TICCIT) programs focuses on their costs, performance, and educaticnal effectiveness. The cost component attempts to measure the costs and assess the economic effects of each of the systems on the participating educational institutions. The technical component monitors the performance of each of the two systems so as to discover and expalin strengths, weaknesses, and implications for further use. The educational component focuses on evaluation of the effect of Ccmputer Assisted Instruction (CAI) upon student performance and behavicr; assessment of the impact of the CAI upon instructors, administrators, and the institution itself; and appraisal of the potential and effect of the methods used to produce, operate, and maintain the course materials. These cost, technical, and educational analyses identify strengths and weaknesses of PLATO and TICCIT, and begin to assess the extent to which the promise of instructional technology has been fulfilled. (RC)

EVALUATION OF THE EDUCATIONAL EFFECTIVENESS OF PLATO AND TICCIT

Ernest J. Anastasio
Donald L. Alderman

Educational Testing Service
Princeton, New Jersey

The evaluation of the PLATO and TICCIT programs is being designed to focus on three major components of the demonstration projects - their costs, performance, and educational effectiveness.

While the thrust of this paper will be to describe the framework for the evaluation of educational effectiveness, brief discussion of the objectives of the cost and performance components is appropriate to provide a complete perspective.

The cost component of the evaluation will attempt to measure the costs and assess the economic effects of each of the systems on the participating educational institutions. In particular, attention will be given to identifying instructional costs and cost effectiveness of courses presented under CAI conditions, to answering questions about the capital, development, and operating costs of each of the two systems, and to estimating indirect costs to participating institutions resulting from adoption of the PLATO or TICCIT system.

The technical component of the evaluation will monitor the performance of each of the two systems so as to discover and explain significant strengths, weaknesses, and implications for future use. Particular attention will be given to assessment of the system specifications to ensure adequacy of design; analysis of the stability of operation and the adequacy of documentations, operating procedures, and maintainability of the system; and appraisal of the appropriateness of the computer system design relative to the state of the art.

The educational component will focus on evaluation of the effect of the CAI upon student behavior and performance; assessment of the impact of the CAI upon instructors, administrators, and the institution itself; and appraisal of the effect and potential of the methods used to produce, operate, and maintain the course materials.

Educational Analysis

Despite substantial prior research in computer-assisted instruction, instructional systems typically lack detailed information regarding their impact upon the educational community. The development of delivery systems and course materials has, in most cases, proceeded without adequate attention to their educational effectiveness. However, the PLATO and TICCIT demonstrations offer an opportunity to assess effects and reactions stemming from computer-based instructional technology and to identify significant educational strengths and weaknesses. The scope of these demonstrations will make possible the collection of detailed information which reflects not only cost and technical sophistication, but also the effects on achievement and educational acceptance. Thus the NSF CAI project extends beyond a development exercise to a study of instructional technology's impact upon the educational institution, upon students, teacher, and administrators. The educational component of the PLATO and TICCIT evaluations will focus upon the consumers of educational innovations in order to determine the practical benefits and problems accompanying computer-based education.

The following framework for the educational analysis presents an overview of educational effectiveness as related to the PLATO and

TICCIT projects. Since "effectiveness" is subject to diverse interpretations, that concept requires as much prior elaboration and specification as possible. The entire context of the evaluation of educational effectiveness will be clarified by the delineation of four essential issues. For the sake of brevity those issues may be posed as four questions that must be answered: the what, who, how, and when of the evaluation. Together these basic questions form the dimensions of an analytical approach to educational effectiveness.

The first task for an educational analysis is to establish what areas of inquiry are appropriate to an evaluation of computer-based education. The cognitive and affective domains represent a gross classification of this "what" dimension. For the cognitive domain, effects upon students' achievement and behavior are our primary interests. For the affective domain, consumers' reactions to the use of an innovative technology will provide important attitudinal information related to educational impact. Through successive refinements of both domains in a hierarchical manner, greater precision and detail will yield indications of what subtopics and issues are relevant to effectiveness. The breadth of coverage incorporated into such a hierarchical specification of the "what" dimension ensures our objectivity; detail permits a telling probe of the shibboleths of computer-based education.

The several audiences concerned with the demonstrations constitute the "who" dimension of the educational analysis. Because of their differing perspectives and preconceptions, each audience serves as an important source of data. Depending on the particular area of inquiry, sources of critical information are the educational institu-

tion, government, industry, and the public. This attention to different societal sectors leads not only to the representation and documentation of diverse viewpoints on educational effectiveness, but also to supportive information for the cost and technical analyses. The expression of affective and cognitive impact across vested interests and characteristics is of course fundamental to the concept of evaluation. Further elaboration of the "who" dimension permits us to establish necessary comparison groups and to represent various groups of persons.

The systematic administration of instruments in the areas of inquiry and to appropriate audiences also requires a plan of how measurement is to be conducted. How instruments are to be administered relates to the available modes for data acquisition. The range of available and proposed means for collecting data includes: tests, records, questionnaires, online systems, interviews, and observations. Each mode has particular demands for instrumentation, ranging from classical test attributes (reliability and validity) to the allocation of personnel and financial resources. Precisely when an instrument should be administered is, similarly, an important consideration, since baseline and concurrent control procedures depend upon coordinating measurement with the timing of administrations. Data collection at specified time intervals is also critical to obtaining trend information about effectiveness over an extended period of time.

Certainly there are interrelationships among these dimensions of the educational analysis, as indicated in Figure 1. Although many combinations of components along these dimensions would be inappropriate for our purposes, the individual cells in this initial

schematic representation of what, who and how do begin to identify information critical for assessing effectiveness. The accumulation of that information will depend, however, upon our first identifying 1) the area of inquiry; 2) the audience to respond; 3) the instrument form used for data acquisition; and 4) the time of administration of the instrument. Through such specification, data can be gathered that attest to the educational stengths and weaknesses of the demonstrations in terms of effects upon users.

Dimensions

A. Areas of Inquiry. To capture the impact of the demonstrations on cognitive skills and attitudes, the evaluation must isolate indicators from the cognitive and affective domains. For the cognitive domain indications of instructional effectiveness are to be gathered through various achievement measures, including standardized tests, objective-based (personalized) tests, and measures of course performance. We shall also supplement information on student achievement with behavioral data on lesson completion, instructional sequence, and other descriptions of cognitive approach toward the subject matter. Activities of students and instructors will serve as indicators of ancillary effects beyond instructional outcomes, such as changes in the distribution of effort and time required to complete course objectives.

Attitudes toward and reactions to instructional technology will be solicited to substantiate and extend information from the cognitive domain. The attitudinal data relevant to the assessment

of educational impact are subsumed under the major categories of courseware, role, and appraisal of computer-based education. Courseware refers to the instructional material employed in the demonstrations; this category encompasses content from the subject area, instructional strategy, mode of delivery to the student, and procedures for producing instructional materials. Role refers to attitudes and receptivity toward the use of computer-based instruction. Appraisal concerns the priorities and basis for evaluation held by different audiences. These three classifications of inquiry are intended as guidelines in the development of items for the instruments.

The delineation of the areas of inquiry from broad concepts to specific indicators is illustrated in Figure 2 by a hierarchical representation. As may be seen, ambiguous concepts are brought through successive refinements to the level of specific issues or item-stems. Priorities in the evaluation are implied by left-to-right positioning along each level of the hierarchy. Since courseware influences cognitive effects and is amenable to review by subject-matter experts and instructional psychologists, a relationship between the cognitive domain and courseware is depicted. Brackets enclose production to emphasize that responses in this area pertain only to logistical, not instructional, issues. The hierarchical schema presents a partial elaboration of the "what" dimension in the educational analysis. Though incomplete, the portrayed hierarchy is intended to convey both the depth and breadth of inquiry; it also begins to specify priorities for the allocation of resources. Subsequent analyses will serve to highlight certain information, from the broad coverage, which reveals the strengths and weaknesses of the respective demonstrations.

B. Audiences. Within the context of planning the educational analysis, audiences (see Figure 3) are meant to denote those persons from whom responses will be gathered in the various areas of inquiry. To allow the expression of significant viewpoints potential respondents include representatives of the educational institution, government, public, and industry. Potential data sources in these sectors are: 1) students, instructors, and administrators in the participating schools and colleges; 2) state and local boards of education responsible for policies in those schools and colleges; 3) parents of children in the elementary schools (PLATO project only) and visitors to the demonstration sites; 4) committees that advise community colleges on the content areas; and 5) manufacturers of system components for PLATO and TICCIT. The focus of attention during the present baseline period is the educational institution, i.e. participants in the cooperating schools and colleges.

Certain characteristics of students, instructors, and administrators are relevant to identifying appropriate audiences and to establishing proper comparison groups. The first such characteristic is participant status in the demonstrations. For students, participation is determined by enrollment in classes or courses scheduled to use PLATO or TICCIT instruction; for instructors, by responsibility for, or supervision of, CAI in a course or class; for administrators, by responsibility for the implementation of the PLATO or TICCIT program. For those students and instructors who have no direct contacts with CAI, another attribute is the similarity between computer-based and conventional instruction. This similarity of courses entails overlap in instructional objectives and resource materials. Identification

of students in, and instructors of, courses which parallel computer-based instruction will permit an additional comparison of instructional outcomes.

Further classifications of respondents within the educational institution relate to the particular district, school, and course or department. This information is required to investigate effectiveness across content areas, schools, and districts, and to recognize natural differences among audiences. Although a breakdown by districts, schools, and courses or departments appears applicable to students and instructors, administrative positions usually satisfy only one of these categories according to the responsibility of an office.

While the above delineation of the "who" dimension suffices for a preliminary identification, other characteristics are certainly important in establishing comparable or matched groups for analysis. Beyond descriptive information for classification, variable traits such as student aptitude or instructor experience might influence achievement or attitude. Matched groups, random assignment, and covariance procedures offer means to overcome anticipated control difficulties. The available control procedures and the multitude of potential respondents suggest that comparison groups for computer-based and conventional instruction are accessible. In addition, the use of baseline and concurrent comparisons for audience classifications provides a view of difference and change attributable to computer-assisted instruction.

C. Modes of Data Acquisition. The modes for acquiring data for the educational analysis are enumerated as: tests, records, questionnaires, online systems, interviews, and observations. Tests in standardized and objective-based form are appropriate for the instrumentation of cognitive inquiries. This information on student achievement and, possibly, aptitude will be complemented by records and online systems. School records will provide additional data on achievement and aptitude by providing course grades and test scores; they may furnish supplemental information by supplying data on school attendance. Online systems provide pertinent achievement and behavior information through various evaluations of student progress, and descriptions of student interaction and sequencing through courseware. The abundance of online information encompasses: performance on reviews, exercises, and tests; completion of required and optional materials; latencies; time spent at terminal. Systematic observations, especially in the elementary schools, mediate the accumulation of behavioral data.

Questionnaires and interviews will constitute the primary means for data collection in the affective domain. Questionnaires facilitate the accumulation of information on audience activities, experience, characteristics, and opinions regarding computer-assisted instruction and conventional practices. Interviews provide an opportunity to elaborate attitudes through group and individual discussions. Possibly online systems can be designed to gather attitudinal data from participants and site visitors. (The preceding points illustrate the interrelationship of instrumentation with areas of inquiry and audience.)

D. When: Time of Data Acquisition. Another consideration in instrumentation is the time of administration. As mentioned earlier, baseline and concurrent control procedures are an integral part of the evaluation. Baseline measures permit the identification of reference points for achievement and attitude before the introduction of computer-based education. Since time differences between baseline and demonstration periods might result in a different set of respondents, concurrent comparisons between participants and non-participants are required to substantiate data in the educational analysis. The time selected for instrument administration is also crucial to the use of pre- and posttests as indicators of student achievement.

In conclusion, the evaluation for the PLATO and TICCIT projects will certainly address fundamental issues in computer-based education. Many of those issues pertain to questions which potential users might raise concerning practical expectations. Yet the simplest questions (e.g. which is better?) are perhaps the most difficult to answer, since neither PLATO and TICCIT can be expected to resolve all problems in education or to meet the criteria of every individual. Information will also become available to answer numerous important questions about the impact of instructional technology within the educational community. The cost, technical, and educational analyses conducted by ETS will identify strengths and weaknesses for PLATO and TICCIT, and begin to assess the extent to which the promise of instructional technology has been fulfilled.

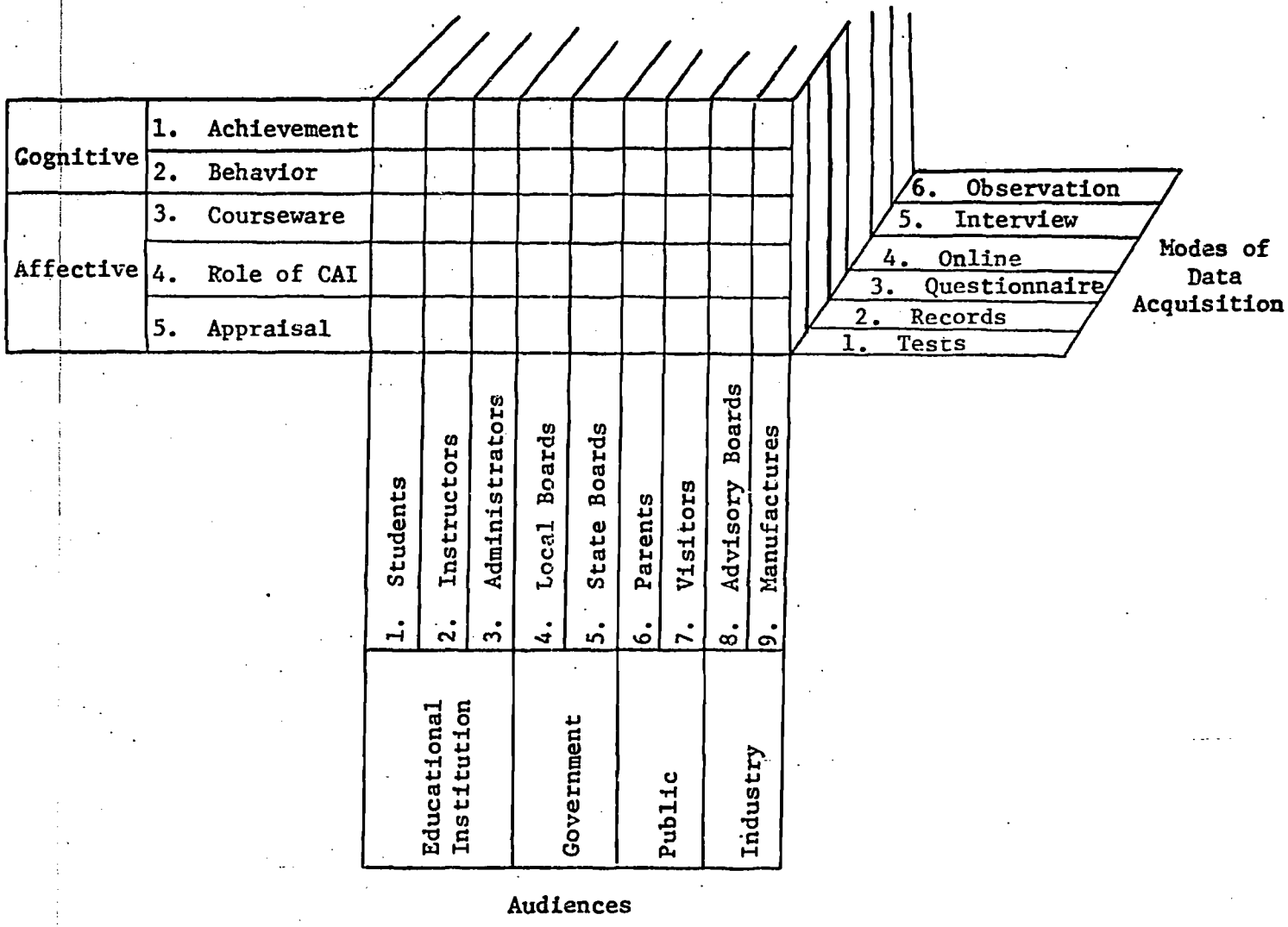

Figure 1
Dimensions of Educational Analysis:
Approach to Effectiveness

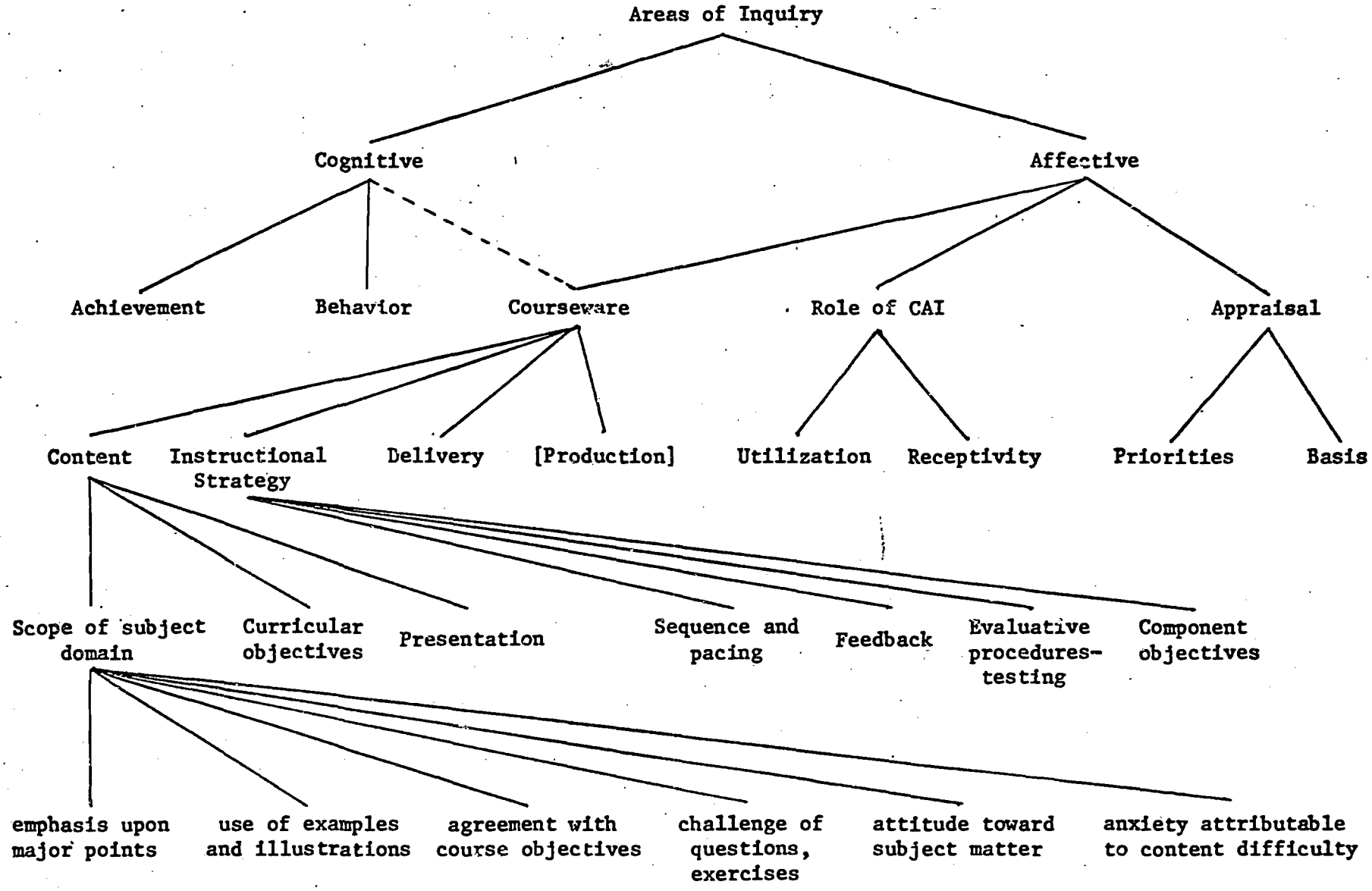

Figure 2
Delineation of Areas of Inquiry

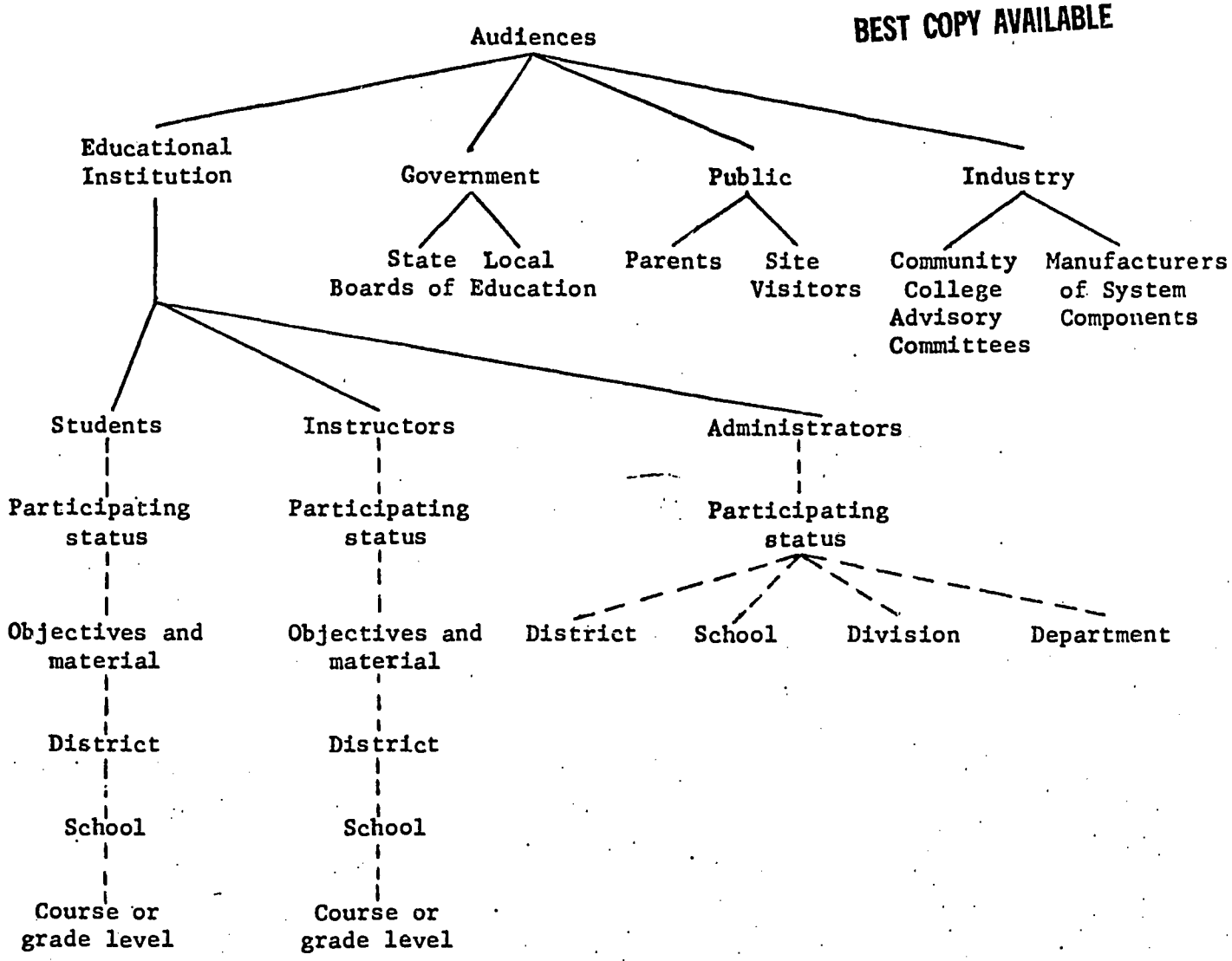

Figure 3
Audience Identification